Water Quality and Temperature Mapping Using ASTER

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INTRODUCTION

Coastal areas are high productive zones in the ocean. Furthermore, 90% of the world's fish catch comes from coastal areas and shelf seas. The rivers are discharging fresh water and also inorganic substances from land to sea. The coastal areas are very important for connecting land and open ocean.

Nearly 50% of the world population lives within 60 km of the coastal areas. Coastal zones are also important for traffic and recreation. However, human activities bring eutrophication in the coastal area. Thus, it is important to investigate these areas and monitor the change of coastal environment. It is necessary to use a spaceborne scanner having a high spatial resolution for monitoring of coastal environment.

Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER), provided by Japanese Ministry of International Trade and Industry, is the only high spatial resolution imager onboard NASA's EOS flagship, Terra, which was launched on December 18 1999. This imaging system provides high spatial resolution data in 14 bands, and along-track stereo imaging capability for producing digital elevation models. Three bands are in the visible and near-infrared (VNIR) with 15 m spatial resolution; six bands are in the short-wave infrared (SWIR) with 30 m resolution, and five bands are in the thermal infrared (TIR) with 90 m resolution. The swath width is 60 km [1][2].

The investigation of oceanography, limnology and sea ice using the ASTER data will include mapping water quality, water surface temperature, aquatic plants, sea ices and coral reefs.

In this paper, early images from ASTER over oceans and bays will be shown. Examples of temperature determination and sediment loading will be shown for Tokyo Bay.

METHODS

Water quality will be processed by the simple band ratio [3] or the inverse method [4] for the retrieval of chlorophyll, suspended matters and yellow substance using 3 VNIR channels.

Water surface temperature will be retrieved by the multi channel regression method using 5 TIR channels as follows,

$$T_{surf} = a + \sum_{i=10}^{14} b_i T_i ,$$

where the factors of a and b_i are regression coefficients and T_i is brightness temperature at channel i [5]. The initial values of a and b_i are determined by numerical calculation using radiative transfer codes such as MODTRAN.

RESULTS AND DISCUSSIONS

The ASTER data were obtained for Tokyo Bay on 29 March 2000. The level 1A data were supplied by ERSDAC Japan. Unfortunately, the level 1B data have not been supplied yet due to errors in Level 1 processing. Thus, the retrieval of water quality and sea surface temperature was not carried out. However, a false color image using VNIR data can be used to grasp relative distribution of water quality. The channel 13 image also shows the relative distribution of water surface temperature. Figure 1 shows the false color image using VNIR. The light blue means turbid area and dark blue means clear area.White color shows clouds. Figure 2 shows the relative thermal image using channel 13 (10.25 – 10.95 •m). The light gray means high temperature and dark gray means low temperature. The turbid and high temperature waters from the rivers were recognized from Figs. 1 and 2. These waters flow to the north by flood tide.

In the near future, after the finalization of Level-1 processing procedures and the release of radiometric calibration coefficients, determination of water quality and surface temperature will be possible using algorithms described above. Also, comparisons between ASTER and other instruments on Terra, such as MODIS, will provide a new view of oceanographic phenomena.

References

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Figure 1 ASTER VNIR false color composite image (B: Ch. 1, G: Ch. 2, R: Ch. 3n) of Tokyo Bay at 29 March, 2000.

Figure 2 ASTER TIR channel 13 Image of Tokyo Bay at 29 March, 2000..